

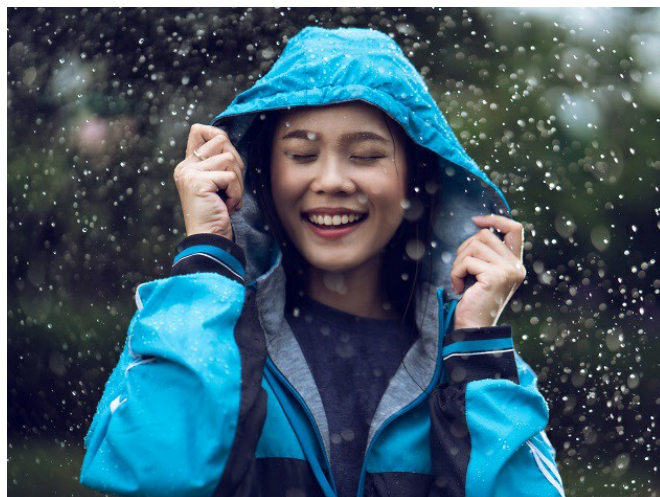
DATASHEET APPLICATION NOTE A078-ST99 - WATER-REPELLENT FABRICS AND TEXTILES

APPLICATION NOTE

Using evaporation to create hydrophobic coating

with mass flow instruments

Empa, one of our European research customers, uses a Bronkhorst evaporation system named CEM (Controlled Evaporation & Mixing) in their quest to develop hydrophobic coatings for water-repellent fabric. Empa, a Swiss Federal Laboratory for Materials Science and Technology and a part of the ETH Domain, employs a CEM system comprising a liquid mass flow meter and a gas mass flow controller. This system actively evaporates silicon organic HMDSO. Empa uses plasma polymerisation to deposit thin (nanoscale) layers on top of fabrics and fibers. In this process flow controllers add the polymer precursors.



Application requirements

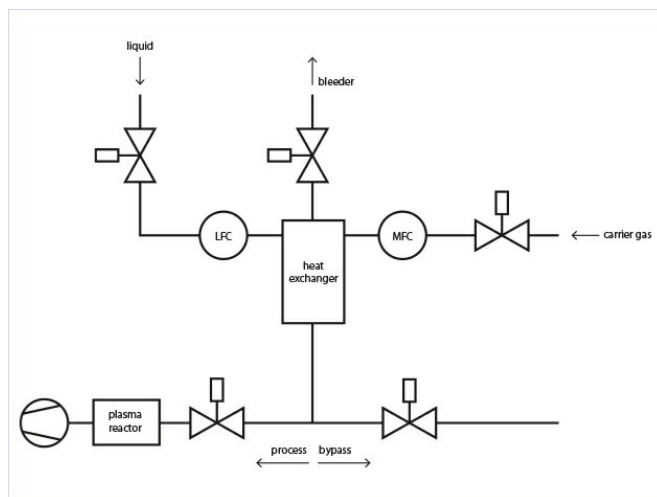
The vacuum plasma (7×10^{-2}) polymerization process at Empa, activates the liquid silicon-organic compound hexamethyldisiloxane (HMDSO - $C_6H_{18}OSi_2$). The primary objective is to polymerize and deposit the resulting vapor onto the surface of the fiber, creating a hydrophobic coating. To achieve a stable and consistent flow of the polymer precursor vapor, precise control is required for both the liquid HMDSO flow and the carrier gas flow. The HMDSO vapor is introduced into the plasma chamber at defined flow rates, where higher rates facilitate rapid deposition and processing.

Important topics

- Accurately controlled gas/liquid mixture
 - Stable vapor flow
 - Low to high vapour flow rates
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Process solution

The Bronkhorst CEM evaporation system evaporates the organic silicon compound HMDSO (hexamethyl-disiloxane). In this process, liquid HMDSO is supplied from a pressurised container at ambient temperature, and the flow rate is measured by the liquid mass flow meter (mini CORI-FLOW series) and its mixing valve. This valve in the CEM system is also responsible for introducing and mixing the liquid HMDSO with the carrier gas, argon in this case, from a thermal mass flow controller (EL-FLOW Select series). The mixed and vaporised fluid then passes through the temperature-controlled heat exchanger, enabling the liquid phase to change to the vapour phase. This vapour flow is then introduced into the reactor, which operates under vacuum conditions at 7×10^{-2} Torr. The entire evaporation and reaction process is controlled via a supervisory system. Thanks to this configuration, HMDSO can be evaporated over a wide range, from 1 to 30 grams per hour. The results demonstrate a very stable, precise, consistent and efficiently regulated vapour flow.



Flow scheme showing CEM evaporation system

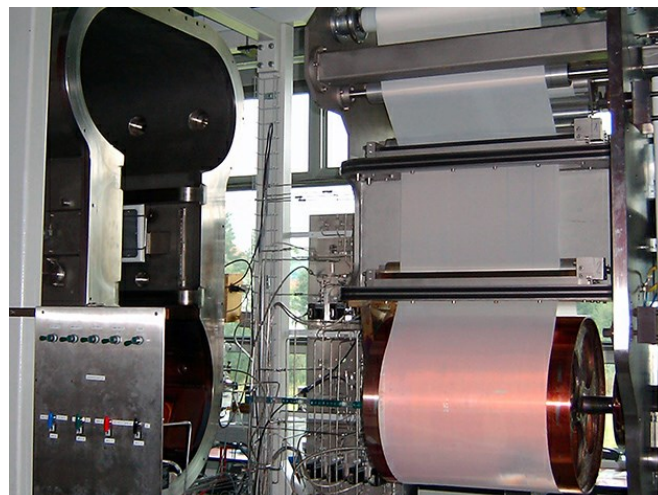
Software used in this evaporation process

The evaporation process in this setup utilizes LabVIEW software for simple and effective visualization. The traditional bubbler system, which had a limited low flow rate of carrier gas and precursor, has been replaced by the currently used CEM vapor system. This transition has brought several benefits.

Benefits gained using CEM evaporation system

With the CEM system, Empa achieves a higher gas yield of 50 ml/min compared to the previous bubbler system, which only allowed 4-5 ml/min of gas flow. Additionally, the flow of HMDSO liquid has been increased. Empa's goal is to scale up the process from the laboratory scale to an industrial scale.

The CEM system currently used at Empa is portable and compact. This mobile setup, resembling a small office table on wheels, enables easy movement between laboratories. The compactness of the Bronkhorst devices further enhances the flexibility of engineered flow solutions.



The HMDSO setup enables the deposition of polysiloxane coatings at low temperatures, making it suitable for coating textile fibers that cannot withstand high temperatures. Empa's efforts to conduct plasma polymerization at low pressure aim to increase production yield by facilitating heterogeneous deposition on the fiber's surface and reducing the amount of chemicals involved.

Recommended Products



EL-FLOW SELECT F-201CV

Min. flow 0,16...8
mln/min
Max. flow 0,5...25 lln/min
Pressure rating 64 bar
Compact design
High accuracy and
repeatability



MINI CORI-FLOW™ M12

Flow range 0...200 g/h
Pressure rating 200 bar
Independent of fluid
properties
High accuracy, fast
response



CEM EVAPORATOR W-102A

Max. 30 g/h liquid;
Max. 4 lln/min gas
Pressure rating 100 bar
Very stable vapor flow
Flexible gas/liquid ratio